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GENERAL SUMMARY OF PROGRESS IN U.S. DIRECTED ENERGY WEAPONS TECHNOLOGY IN 1992

Zhang Yaping

In the last two years, following along with the profound changes which have occured in the world situation, the focus of the U.S. strategic defense initiative (SDI) has already turned toward theater missile defense systems which it is possible to develop and deploy in the near term as well as ground based strategic missile defense systems, and directed energy weapons are being set out as follow on systems. As a result, research and development funding in the area of directed energy weapons is correspondingly reduced as a consequence. However, what is worth paying attention to is that, in this, funding used in the development of chemical laser weapon technologies has not only not been reduced but has very greatly increased. Besides this, it can be expected that design research associated with airborne laser weapons used in theater laser missile defense will also receive a high degree of serious attention in the U.S. military.

In fact, the year 1992 was a year when U.S. directed energy weapon technology research work achievely comparatively clear progress on an adjusted foundation. In this year, the strategic defense initiative office (SDIO) successfully carried out several small scale research experiments related to chemical lasers, free electron lasers, and neutral particle beams and developed new technological research related to theater airborne laser weapons.

I. DIRECTED ENERGY WEAPON TECHNOLOGY RESEARCH PROJECTS HAVE ADJUSTED, STEADY DEVELOPMENT

As soon as SDI projects began, SDIO then took directed energy technologies to be a type of antiballistic missile technology which has a lot of vitality. Although directed energy weapons (DEW) will play the role of follow on weapons systems, and, in conjunction with this, carry out development at comparatively slow speeds, they will still be, however, seen as one type of important advanced defense technology and continue research and development. There is very intense interest with regard to them. Future SDIO strategic defense systems will be able to make use of lasers or particle beams to deliver attacks against targets several thousand kilometers away. After precision acquisition, tracking, and aiming subsystems are fitted on directed energy weapons, they will then be capable of completing all such missions as detection, tracking, identification, intercept, destruction, and kill and damage evaluation.

In the strategic defense initiative, directed energy weapon research and development which is underway includes particle beam weapons (neutral particle beam and charged particle beam

weapons), laser weapons, and nuclear directed energy weapons. Acquistion, tracking, aiming, and fire control (ATP-FC) plans support all directed energy weapon designs. Up to now, for the sake of increasing and expanding the capabilities of sensors and kinetic energy weapons in initial deployments, plan design has already been carried out with regard to directed energy weapons. Technologies which are required by directed energy weapons have already had demonstrations successfully carried out in terms of integrated subsystems. In 1992, the realms of directed energy weapon technologies achieved a good deal of important technical progress. Due to reductions in funding, some projects made certain adjustments.

1. Free Electron Laser Technology Projects Achieve Important Technical Progress After Adjustments

At the end of 1990, SDIO canceled comprehensive tests of large model land based free electron laser technologies and turned to the carrying out of average power laser experiments (APLE). The final APLE apparatus realizes electron beam powers of 2 megawatts. Laser average output powers are 100 kilowatts. Wave lengths are approximately 10 microns. APLE projects are jointly funded by the U.S. Army and SDIO. They are cooperatively carried out by the Boeing company and Los Alamos laboratory.

It is reported that, in August 1992, two important subsystems of APLE--injectors and photocathodes--achieved important technical progress. Injectors are electron injection systems. Because the quality of electron beams determines the magnitude of powers produced by lasers, injectors are, therefore, extremely key with regard to the successful operation of free electron lasers. The new injectors used during tests produced electron beam powers of 680 kilowatts--more than ten fold greater than the powers produced by all other electron beam injectors used at the present time. Electron beam average currents are 40 milliamperes. The electron beam radiated intensities that are measured are one fold higher than those required. Photocathodes are a type of auxilliary system to control free electron laser beam quality. Electron conversion efficiencies associated with new strengthened models of photocathodes are 4-5 times those produced in the past by the same type. During tests, there was continuous operation for more than 3 hours. However, the life of photocathodes in the past was only a few minutes. The U.S. Army space and strategic defense command said that this iteration of tests is "a great technological accomplishment"--an important step in the technological development of high power laser weapons. However, demonstrations of laser weapons possessing adequate power, and, in conjunction with that, used to really destroy

missiles still require ten or more years time.

2. Space Based Alpha Chemical Laser Technology Mature. Progress Draws People's Attention.

Alpha space based chemical laser technology is a comparatively mature field of technology associated with directed energy weapons techniques. Since the first optical output test on 7 April 1989, multiple tests have already been carried out. On 30 November 1990, the first successful full power operation of a megawatt level Alpha chemical laser was carried out. The light beam quality had already reached weapon level standards--adequate to destroy missiles in space. It has already been considered to act as a follow on strengthening model system associated with the global defense system (GPALS) to deliver limited attacks in SDI.

On 16 July 1992, an Alpha space based chemical laser also achieved, during demonstration tests, megawatt level output powers. SDIO said that this was the highest power and the best

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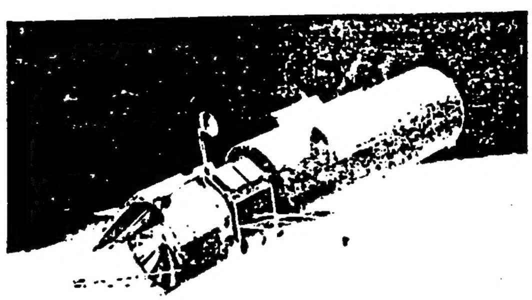

Fig.1 Imagined Space Based Laser Weapons System. Alpha Laser Is Positioned at the Right End of Satellite. The Middle Is Satellite and Light Beam Shaping Components. The Right End Is Aiming and Tracking Sensors and Large Model Segmented Mirrors.

light beam quality since the first iteration of light output in 1989. In tests, it was also the first time demonstration was made of nonrefrigerated silicon reflector mirrors under irradiation from megawatt level power laser light. There was "accurate operation without error" for periods reaching as long as 6.2 seconds. SDIO has already determined to begin "Comprehensive Alpha/Large Model Advanced Reflector Mirror Project Test" (ALI) in 1993. High power tests will be carried out at the end of fiscal 1994 and the beginning of fiscal 1995. Besides this, in 1992, funding associated with chemical laser weapons technology projects (principally TRW company's Alpha chemical laser) grew in a big way. This was primarily because SDIO decided to take large amounts of funding and concentrate it in a directed energy plan. In conjunction with this, selection was made of a comparatively mature chemical laser.

3. Neutral Particle Beam Technology Research Slowed Down in Execution. However, It Has Already Achieved Technological Progress.

One of the missions associated with neutral particle beam weapon technological research work is to develop ground test accelerators (GTA). They are used to act as neutral particle beam systems associated with initial development, high luminosity ion source technology, advanced neutralizer technology, as well as acquisition, tracking, aiming, and fire control associated with main test platforms. In 1992, SDIO carried out tests with regard to drift tube linear accelerators (DTL) associated with the formation of GTA, successfully making use of first stage DTL to make ion beams accelerate. This is a very important step in moving toward the development of the GTA area. The reason is that the ten DTL sections that compose GTA are basically all repetitions of the same type of operational processes. In accordance with requirements, the first DTL stage is capble of taking ion beams and accelerating them to 3.5 mega electron volts. The whole GTA will take ions and accelerate them to 24 mega electron volts.

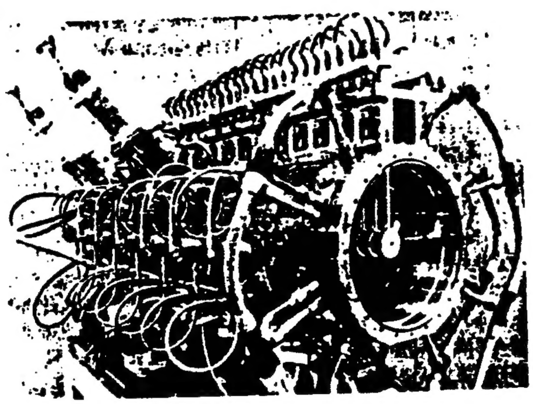

Fig.2 Neutral Particle Beam Drift Tube Linear Accelerator Apparatus

However, in a different area, due to the fact that directed energy funding is reduced, SDIO has no choice but to shrink neutral particle beam projects. In conjunction with this, it determined to take key points from demonstration tests and turn them toward technological development. SDIO's officials are also in the midst of consulting with Russia on the cooperative carrying out of a parallel neutral particle beam test.

4. The Early Death of Nuclear Directed Energy Technology Research Plans

Research associated with nuclear directed energy weapons (NDEW) is set up on the foundation of theoretical research and computer research associated with compatible underground nuclear tests and related laboratory tests.

In 1992, relevent Department of Defense offices responsible

for SDIO formally notified Congress that, in the 1993 fiscal year, there would be no more funding requests for nuclear detonation pump X ray laser weapons or projects related to them. SDIO officials already verified that the 5 million U.S. dollars appropriated by the Defense Department in 1992 for the projects in question would be the last sums. Up to now, no X ray laser weapons have as yet been developed. Moreover, their possibility has also as yet not been verified. The projects in question were set up in SDIO beginning in 1985. SDIO has already invested 131 million U.S. dollars in them. In this, most of the funds come from the Department of Energy (DOE).

An SDIO spokesperson said that, after the disintegration of the Soviet Union, SDIO believed that there was no need to continue this research. X ray laser technology already no longer is a procurement object associated with any SDIO system. /39

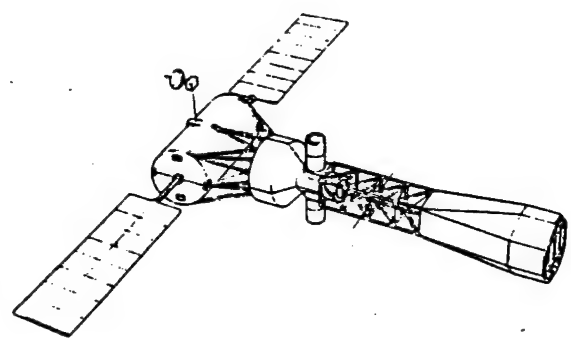

Fig.3 Notional Space Based Neutral Particle Beam System. Injector System Is at Top Left End. Right End Is Neutralizer and

Aiming System.

5. Appropriate Adjustments to Acquisition, Tracking, Aiming, and Fire Control Technology Plans

Due to budget reductions, continuing in February 1991, the anticipated expenditure of 1 billion U.S. dollars in the U.S. space shuttle to carry out the Starlab experimentation project was changed to become the Altair automatic experimentation satellite which was anticipated to cost 330 million U.S. dollars.

After this, in 1992, the U.S. SDIO also canceled the Altair experimentation project, replacing it with the carrying out of comparatively inexpensive balloon borne experiments.

This iteration of tests was divided into two parts. One part used Kestrel balloons launched from warships to observe boost phase missiles, and, in conjunction with this, collection was made of metrological data used in sensor systems. The other part was experiments on balloons launched on the sea and land called high altitude balloon experiments (HABE) with regard to levels of precision of missile weapon tracking and aiming capabilities. Experimental results will be directly applied to Bright Pebble interceptors, Bright Eye detection systems, and theater weapon research work. Up to 1995, Kestrel experiments only require 30 million U.S. dollars. High altitude balloon experiments require 45-50 million U.S. dollars. The expenses in question include development costs and expenses for 5 mission iterations. The first iteration of tests was set for execution in April 1993. Lawrence Livermore national laboratory is responsible for Kestrel tests. The U.S. Air Force Feilipu (phonetic) laboratory is responsible for high altitude balloon tests. It is said that balloon carried experiments will be able to realize most of the objectives associated with the space experiments they replace.

II. THEATER DEFENSE LASER WEAPONS RECEIVE REDOUBLED ATTENTION AND PRIORITY DEVELOPMENT

In the last few years, the international situation has changed abruptly. In particular, the outbreak of the Gulf War stimulated the U.S. SDIO to set its eye on large scale, extremely expensive strategic defense systems and, at the same time, give priority consideration to being able to develop and deploy as rapidly as possible theater defense systems. One among these is then theater defense laser weapons.

The SDIO deputy director for technology, Air Force Colonel Pite Wodeng (phonetic) said: "The prospects for directed energy weapon technology projects will be dependent on when we will be able to deploy as rapidly as possible feasible, low cost systems." The first objective he selected was the deployment of airborne laser weapons with kill and damage ranges of 400-500km. To this end, the U.S. SDIO and the Navy and so on respectively developed corresponding research projects.

1. The "Desert Flash" Project

After the Gulf War, SDIO developed a project called "Desert Flash", exploring what type of results would be produced assuming deuterium flouride/hydrogen flouride (DF/HF) lasers, chemical oxygen iodine lasers (COIL), and free electron lasers (FEL) were used to replace Patriot missiles in order to deal with Fleet Footed Runner (SCUD) missiles during the Gulf War. By June 1992, an evaluation report had already been submited to the Department of Defense. Funding for this study was provided by the national defense nuclear agency subordinate to the SDIO. Carrying it out was the responisibilty of the U.K. Logica company and a New York polytechnical university.

2. U.S. Navy Demonstrates the Efficiency of Warship Borne Laser Weapons

In 1992, the U.S. Navy began to carry out theater application demonstrations of warhsip borne high energy laser weapons, evaluating their military value in association with handling nap of the ocean cruise missiles and detecting sea mines. Investments are expected to be 2 million U.S. dollars. Research on combat simulations will be the responsibility of the Naval Academy and the Naval Surface Warfare Center. In 1992, the Naval Analysis Center already completed a study demonstrating that laser weapons systems installed on surface warships are capable of being designed for installation in volumes of space occupied by such guns as 12.7cm (5 inch). TRW company estimates that the development and design of a warship borne laser weapon system will require the expenditure of approximately 250 million U.S. dollars. Testing and evaluation of this type of weapon system will also require 250 million U.S. dollars.

3. SDIO Implements Two Airborne Laser Weapon Research Projects /40

In 1992, SDIO formally began implementation of two airborne laser weapon research projects. In 1992 and 1993, the main thing is research on questions associated with laser atmospheric propogation characteristics and atmospheric compensation. The first project lasts one year. Expenses are 10 million U.S. dollars. Development has already begun at the Air Force's Feilipu (phonetic) laboratory in March 1993. The main thing is

to measure the influences of atmospheric turbulence on laser transmission when laser beams are fired at Fleet Footed Runner (SCUD) missiles. If progress is smooth, in 1994, there will be a decision to begin a multiple year, airborne chemical laser weapon demonstration project associated with a large model, wide body aircraft (for example, a Boeing 747). The execution of another project will be the responsibility of the Los Alamos laboratory, studying small model solid laser weapon designs carried by small model aircraft or pilotless aircraft. During tests, laser beams fired directly from high altitude pilotless aircraft

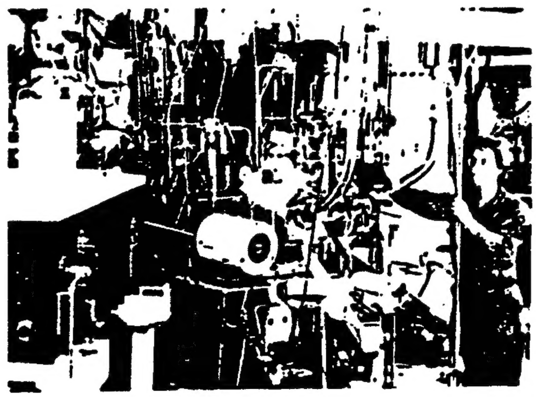

Fig.4 Chemical Oxygen Iodine Laser in the Process of Testing at Feilipu (Phonetic) Laboratory

are used to avoid the influences of atmospheric turbulence on laser transmission. Deputy chief of the SDIO directed energy office, Air Force Colonel Lanni Lasen (phonetic), said: "Preliminary research results associated with airborne laser weapons projects are encouraging. They have the possibility of leading to the carrying out--in the later part of the 1990's--of full airborne laser weapon design demonstration test projects. When the time comes, the first verifications will be of the capability of airborne laser weapons to intercept tactical ballistic missiles (illegible) 100km and that interception ranges for distant targets are raised to 400-500km. SDIO is capable, within the first 4 years of the beginning of an adequately funded project, to test and verify airborne laser weapon designs and deploy a combat system in 2005.

At the present time, the power of large model oxygen iodine chemical lasers developed by the U.S. Air Force Feilipu (phonetic) laboratory is 25 kilowatts. The main work of the laboratory is to make lasers lighter weight and efficiencies higher. The final objective is to take a several megawatt laser unit and install it in a large model, wide body aircraft used to intercept missiles in boost phase several hundred kilometers away. Feilipu (phonetic) laboratory asserts that in the years

1995-1996 it will be possible to test and verify airborne laser weapon effective ranges as 100km. After improvements, the effective range in 1998 can increase to 250km. The final effective range is 400km. The first phase can consider opting for the use of high power chemical oxygen iodine lasers as well as related equipment.

Small model solid lasers carried on small model aircraft or pilotless aircraft, developed by Lawrence Livermore laboratory, have already achieved breakthrough progress. In July 1992, small model solid lasers had already been developed with volumes even smaller than a shaddock, output powers of 1000 watts, and operating wave lengths of 1.06μm. The research results in question are important milestones in the development of laser weapon technology research. The laser weapons in question opt for the use of advanced solid laser diode pumps as well as microchannel refrigeration methods, extremely high efficiencies, and very light weights. It is reported that, in 1992, Russia has already agreed to sell its very advanced laser technology to the laboratory in question. With the help of this, Lawrence Livermore laboratory will be able to make the powers of its laser devices increase drastically from 1000 watts, at the present time, to several megawatts--adequate to let them act as a type of effective short range weapon.

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ITALY URGES NASA TO AGAIN TEST MOORING SATELLITE

Chen Xiaonan Xiao Ping

Translation of "Yi Da Li Dun Cu NASA Zai Ci Wei Qi Shi Yan Ji Liu Wei Xing"; Aerospace China, No.5, May 1993, p 40

The U.S. NASA has already notified the Italian Space Agency (ASI) that it may, within 2-4 years, again release a mooring satellite manufactured by the Alieniya (phonetic) astronvavigation company. However, it will only be possible to make a final decision after 6 months. The objective of mooring satellite flight tests carried out by the space shuttle in August 1992 was to verify the dynamics theory associated with mooring components in space, and, in conjunction with that, observe whether or not mooring cable made of electrically conducting material was able to send out electricity while moving in space. For this flight, NASA provided the space shuttle flight opportunity and, in conjunction with this, spent 180 million U.S. dollars for mooring lines, winding structures, as well as a number of experimental components. ASI estimates that expenses associated with the second flight are 13.3 million U.S. dollars. However, delaying two years or even longer will make expenses increase to 20 to 33 million U.S. dollars. Italy hopes that it will be possible to complete the flight within two years. It would be best to carry out the flight in 1993. ASI has already urged NASA to organize this flight. At a minimum, it will still be necessary to reach a conclusion in order to facilitate letting the Italian side determine the disposition of its technical team. ASI is in the midst of considering increasing illumination equipment on the next flight in order to facilitate seeing from the space shuttle to mooring satellites.